REMARKS / DISCUSSION OF ISSUES

The present amendment is submitted in response to the Office Action mailed January 6, 2009. Claims 1-17 remain in this application. In view of the remarks to follow, reconsideration and allowance of this application are respectfully requested.

The Invention

Prior to addressing the substantive rejections, it is instructive to briefly review the invention. The invention provides a method of estimating the state-of-charge of a rechargeable battery, taking into account the factors battery spread and ageing. Spread leads to variations in behavior of batteries of the same batch. Ageing of a battery will cause the parameters determining the battery behavior to change. A main feature of the method is that the state-of-charge (SoC) estimation is performed by means of voltage measurement when the battery is in the so-called equilibrium state and by means of current measurement when the battery is in a non-equilibrium state. In the case of equilibrium no or only a small external current flows and the battery voltage has fully relaxed from previous charges or discharges. A simple method to update the maximum capacity of the battery Cap_{max} is based on relating the integrated charge withdrawn from a battery in non-equilibrium (discharge) mode to the difference in SoC (in %) in equilibrium mode directly before and after the non-equilibrium mode (i.e., a first and second equilibrium state). The invention takes into account the fact that in practical use, a portable device that employs the SoC method of the invention may take a long time to reach the transitional state. Therefore, it is plausible that very often the second equilibrium state is not reached and SOC_E cannot be determined, because the user will switch on the device again leading to a shift back to discharge state. The method of the invention overcomes this obstacle by utilizing an updating mechanism for Cap_{max} that take advantage of the fact that the update for Cap_{max} is performed during charging without requiring the device to reach the second equilibrium state. Hence, a method of estimating the state-of-charge of a Li-ion battery, comprising the steps of: measuring the voltage across the battery during a first measurement and converting this measured value into the state-of-charge (SoC_s); subsequently charging the battery; measuring the voltage across the battery during a second measurement and converting this measured value to a measured state-of-charge value (SoC_e);

determining the accumulated charge during charging by integration of the charge current; subtracting the measured state of charge (SoC_s) in the first measurement from the state-of-charge (SoC_e) in the second measurement; and updating the value of the maximum capacity of the battery (Cap_{max}) by relating the charge withdrawn from the battery with the result of the subtraction (SoC_e-SoC_s), characterized in that at least the second measurement is executed during charging.

I. Claim Rejections under 35 USC 101

Claim 6 stands rejected under 35 U.S.C. §101 as being allegedly directed to non-statutory subject matter. As per claim 6, the rejection is understood to be based on the premise that the claim merely discloses mathematical manipulations without clearly stating the use or purpose of the manipulations and is thus non-statutory. Claim 6 has been amended in a manner which is believed to overcome the rejection. More particularly, claim 6 has been amended into independent form to recite a method to allow **an assessment** of the state-of-charge at times when a battery is charged or discharged. Accordingly, withdrawal of the rejection is respectfully requested.

II. Claim Rejections under 35 USC 102

In the Office Action, Claims 1, 5, 13-15 and 17 stand rejected under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 6,845,332 ("Terou"). Applicants respectfully traverse the rejection.

I. Claims 1, 5, and 13-14 are allowable

The cited portions of Terou do not anticipate claim 1, because the cited portions of Terou fail to disclose every element of claim 1. For example, the cited portions of Terou fail to disclose or suggest "*measuring the voltage across the battery during a first measurement and converting this measured value into the state-of-charge (SoC_s)*", as recited in claim 1 (Emphasis Added). Instead, the cited portions of Terou disclose in step S404, the battery ECU 116 calculates the SOC 1 based on the calculated current integrated value. It is respectfully submitted that measuring the voltage across the battery during a first measurement and converting the measured voltage is different than calculating an SOC 1

value based on the calculated current integrated value. Therefore, the cited portions of Terou fail to disclose or suggest "*measuring the voltage across the battery during a first measurement and converting this measured value into the state-of-charge (SoC_s)*", as recited in claim 1.

Further, the cited portions of Terou fail to disclose or suggest *"subsequently charging the battery; measuring the voltage across the battery during a second measurement and converting this measured value to a measured state-of-charge value (SoC_e)*", as recited in claim 1. Instead, the cited portions of Terou disclose in step S416, the battery ECU 116 calculates SOC 2 based on the calculated electromotive voltage V2. It is respectfully submitted that charging the battery, measuring the voltage across the battery and converting a measured voltage to a state-of-charge value is different than calculating an SOC 2 value based on a calculated electromotive voltage V2. Further, the electromotive force taught in Terou is different from the voltage measured across the battery, as recited in claim 1. That is, the electromotive voltage V1 of the battery in Terou is not identical to the battery voltage but is instead calculated based on a terminal voltage V. The electromotive voltage V1 of the secondary battery in Terou is the value obtained by deducting the charge/discharge polarization voltage and the internal resistor drop voltage from the terminal voltage. It is submitted that calculating an electromotive voltage V1 is different from directly utilizing the measured voltage across the battery.

Further, there is no teaching or suggestion in Terou of subsequently charging the battery. In fact, Terou teaches away from charging the battery in that Terou discloses that it is an object of the invention to provide an SOC calculation device and an SOC calculation method for a battery which can ensure that SOC is estimated with a high degree of accuracy, without depending on the battery charge and discharge level. *See* Terou, Summary.

The method of Terou recites a current detection portion that detects discharge current of a battery; and a voltage detection portion that detects a voltage of the battery; and a controller for

- calculating a first state of charge estimate by integrating the detected discharge

current, and

- correcting the first state of charge estimate using an electromotive voltage correction parameter, that is determined using an electromotive voltage based on the detected voltage,
- wherein the controller determines a second state of charge estimate based on the electromotive voltage,
- determines a correction amount based on a difference between the first state of charge estimate and the second state of charge estimate using the electromotive voltage correction parameter, and
- corrects the second state of charge estimate using the correction amount.

Applicants submit that the method of the invention operates in a different manner than the method of Terou. It is submitted that the method of the invention does not perform at least the steps of Terou as underlined above. In particular, the inventive method does not disclose or suggest corrective parameters. In contrast to the method of the invention, the method of Terou utilizes an electromotive voltage correction parameter for correcting the first and second state of charge estimates. Terou uses the corrective parameter for SOC together with the electromotive voltage of the battery (step S510 of Terou). In order to realize this, a map of the electromotive voltages and correction parameters is prepared in advance, and the correction parameter is determined based on this map. The method of the invention does not teach or suggest the use of a map of electromotive voltages and correction parameters. The correction parameters of Terou are determined such that when the SOC of the battery which is determined based on the current integrated value is corrected by the electromotive voltage of the battery, the correction amount is larger at SOC levels where the SOC estimate based on the electromotive voltage is more accurate, and the correction amount is smaller at SOC levels where the estimate is less accurate. As a result, is it possible to both improve the accuracy of the SOC estimate at all SOC levels, and provide a highly accurate SOC calculation method regardless of the charge and discharge pattern.

Based on the foregoing, it is respectfully submitted that claim 1 is allowable.

Claims 5, 13-14 and 17 depend from claim 1, which Applicant has shown to be allowable. Hence the cited portions of Terou fail to disclose or suggest at least one element of each of claims 5, 13-14 and 17. Accordingly, claims 5, 13-14 and 17 are also allowable, at least by virtue of their dependence from claim 1.

Independent Claim 15 recites similar subject matter as Independent Claim 1 and therefore contain the limitations of Claim 1. Hence, for at least the same reasons given for Claim 1, Claim 15 is believed to recite statutory subject matter under 35 USC 102(e).

III. Claim Rejection under 35 USC 103

The Office has rejected claims 2-3 at paragraph 12 of the Office Action, under 35 U.S.C. §103(a), as being unpatentable over Terou and further in view of U.S. Patent No. 5,747,969 ("Tamai"). Applicant respectfully traverses the rejection.

Claims 2-3 are Allowable

As explained above, Terou does not disclose or suggest each and every element of claim 1, from which claims 2-3 depend. Specifically, the cited portions of Terou fail to disclose or suggest "*measuring the voltage across the battery during a first measurement and converting this measured value into the state-of-charge (SoC_s)*", and *"subsequently charging the battery; measuring the voltage across the battery during a second measurement and converting this measured value to a measured state-of-charge value (SoC_e)*", as recited in claim 1. Tamai does not disclose the elements of claim 1 that are not disclosed by Terou. Tamai is cited by the Office for teaching that "during the second measurement the current has a value at which the battery can be regarded to be in equilibrium". Hence, there is no teaching or suggestion in Tamai of "*measuring the voltage across the battery during a first measurement and converting this measured value into the state-of-charge (SoC_s)*", and *"subsequently charging the battery; measuring the voltage across the battery during a second measurement and converting this measured value to a measured state-of-charge value (SoC_e)*", as recited in claim 1. Therefore, the combination of Terou and Tamai do not disclose each and every element of claim 1, from which claims 2-3 depend. Hence, claims 2-3 are

allowable.

IV. Claim Rejections under 35 USC 103

The Office has rejected claim 4 at paragraph 15 of the Office Action, under 35 U.S.C. §103(a), as being unpatentable over Terou and further in view of Tamai and U.S. Patent No. 6,549,014 ("Kutkut"). Applicant respectfully traverses the rejection.

Claim 4 is Allowable

As explained above, Terou does not disclose or suggest each and every element of claim 1, from which claim 4 depends. Specifically, the cited portions of Terou fail to disclose or suggest "*measuring the voltage across the battery during a first measurement and converting this measured value into the state-of-charge (SoC_s)*", and *"subsequently charging the battery; measuring the voltage across the battery during a second measurement and converting this measured value to a measured state-of-charge value (SoC_e)*", as recited in claim 1.

Tamai does not disclose the elements of claim 1 that are not disclosed by Terou. Tamai is merely cited by the Office for teaching that "charging takes place by a pulsed current and that the measurements of voltage and current of the battery are subjected to low pass filtering." Hence, there is no teaching or suggestion in Tamai of "*measuring the voltage across the battery during a first measurement and converting this measured value into the state-of-charge (SoC_s)*", and *"subsequently charging the battery; measuring the voltage across the battery during a second measurement and converting this measured value to a measured state-of-charge value (SoC_e)*", as recited in claim 1.

Kutkut does not disclose the elements of claim 1 that are not disclosed by the combination of Terou and Tamai. Kutkut is merely cited by the Office for teaching that "measurements of voltage and current of a battery are subjected to low pass filtering." Hence, there is no teaching or suggestion in Kutkut of "*measuring the voltage across the battery during a first measurement and converting this measured value into the state-of-charge (SoC_s)*", and *"subsequently charging the battery; measuring the voltage across the battery*

during a second measurement and converting this measured value to a measured state-of-charge value (SoC_e)", as recited in claim 1.

Therefore, the combination of Terou, Tamai and Kutkut do not disclose each and every element of claim 1, from which claim 4 depends. Hence, claim 4 is allowable.

V. Claim Rejections under 35 USC 103

The Office has rejected claims 7-12 at paragraph 17 of the Office Action, under 35 U.S.C. §103(a), as being unpatentable over Terou and further in view of U.S. Patent Application No. 2002/0117997 ("Feil"). Applicant respectfully traverses the rejection.

Claims 7-12 are Allowable

As explained above, Terou does not disclose or suggest each and every element of claim 1, from which claims 7-12depend. Specifically, the cited portions of Terou fail to disclose or suggest "*measuring the voltage across the battery during a first measurement and converting this measured value into the state-of-charge (SoC_s)*", and *"subsequently charging the battery; measuring the voltage across the battery during a second measurement and converting this measured value to a measured state-of-charge value (SoC_e)*", as recited in claim 1. Fiel does not disclose the elements of claim 1 that are not disclosed by Terou. Fiel is cited by the Office for teaching that "a value of SOC is used to calculate an estimation of the remaining time of use of a battery." Hence, there is no teaching or suggestion in Fiel of "*measuring the voltage across the battery during a first measurement and converting this measured value into the state-of-charge (SoC_s)*", and *"subsequently charging the battery; measuring the voltage across the battery during a second measurement and converting this measured value to a measured state-of-charge value (SoC_e)*", as recited in claim 1. Therefore, the combination of Terou and Fiel do not disclose each and every element of claim 1, from which claims 7-12 depend. Hence, claims 7-12 are allowable.

The Office has rejected claim 4 at paragraph 15 of the Office Action, under 35 U.S.C. §103(a), as being unpatentable over Terou and further in view of Tamai and U.S. Patent No. 6,549,014 ("Kutkut"). Applicant respectfully traverses the rejection.

VI. Claim Rejections under 35 USC 103

The Office has rejected claim 16 at paragraph 23 of the Office Action, under 35 U.S.C. §103(a), as being unpatentable over Terou and further in view of Kutkut. Applicant respectfully traverses the rejection.

Claim 16 is Allowable

As explained above, Terou does not disclose or suggest each and every element of claim 1, from which claim 15 depends. Specifically, the cited portions of Terou fail to disclose or suggest conversion means for converting the measured voltage to the state-of-charge of the battery (SoC_s) using said storage means", as recited in claim 15.

Kutkut does not disclose the elements of claim 15 that are not disclosed by Terou. Kutkut is merely cited by the Office for teaching that "low pass filtering is incorporated into the measuring means" Hence, there is no teaching or suggestion in Kutkut of "conversion means for converting the measured voltage to the state-of-charge of the battery (SoC_s) using said storage means", as recited in claim 15.

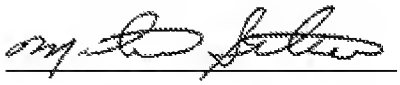
Therefore, the combination of Terou and Kutkut do not disclose each and every element of claim 15, from which claim 16 depends. Hence, claim16 is allowable.

Conclusion

In view of the foregoing amendments and remarks, it is respectfully submitted that all claims presently pending in the application, namely, Claims 1-17 are believed to be in condition for allowance and patentably distinguishable over the art of record.

If the Examiner should have any questions concerning this communication or feels that an interview would be helpful, the Examiner is requested to call Mike Belk, Esq., Intellectual Property Counsel, Philips Electronics North America, at 914-945-6000.

Respectfully submitted,



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